ET40

ELECTRICAL WORKERS REGISTRATION BOARD

Safety • Competency

Candidate Code No.	
For Board Use Only	
Result	Result
Date	Date
Int	Int

ELECTRICIAN'S THEORY EXAMINATION

19 November 2011

QUESTION AND ANSWER BOOKLET

Time Allowed: Three hours

INSTRUCTIONS – READ CAREFULLY

You have 10 minutes to read this paper but do not start writing until you are told to do so by the supervisor.

Write your Candidate Code Number in the box provided above. Your name must NOT appear anywhere on this paper.

Answer all questions.

The pass mark for this examination is 60 marks.

Use a pen for written answers. **Do not** use a pencil or a red pen.

Drawing instruments and pencils may be used when diagrams are required. Marks are allocated on the basis of correctness.

Do not use correcting fluid or correcting tape.

For calculation questions all workings, including formulae, must be shown to gain full marks.

Non-programmable calculators may be used.

Warning – You could get 0 marks for any question, or part of a question, if you show anything hazardous or dangerous in your answer.

Candidates are not permitted to use any Act, Regulation, Standard, Code of Practice, Handbook or other reference text in this examination.

PLEASE HAND THIS PAPER TO THE SUPERVISOR BEFORE LEAVING THE ROOM.

(turn over)

Question 1

(a) (i) Draw the circuit symbol for a **Triac** and label the terminals.

(1 mark)

(ii) Draw the circuit symbol for a **Zener Diode** and label the terminals.

(1 mark)

(b) The three-phase PVC flexible cable supplying a 400V three-phase motor has been replaced with a three core neutral-screened flexible cable.

State **TWO** advantages that a neutral-screened flexible cable has when compared to a PVC cable.

(2 marks)

(1) ______________________________

____

(2) ______________________________

____

(turn over)

Question 1 continued

(c) (i) For which type of protective device is the term **tripping factor** used.
(½ mark)

____

(ii) Define the term **tripping factor**.
(1½ marks)

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(d) Two identical 100 kVA transformers of the **same impedance** are used to supply separate industrial electrical installations. In the first installation the 100kVA transformer is located 20 metres from the boundary of the installation.

In the **second** installation the 100kVA transformer is located within the installation

State the main reason why the **second** electrical installation will have a larger prospective short circuit current than the other electrical installation.
(2 marks)

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(turn over)

Question 1 continued

(e) (i) Describe how the **prove-test-prove** method of testing is carried out.

(1½ marks)

(ii) You are doing a polarity test to find out if the supply to a **three-phase** main switchboard has been isolated.

Between which terminals would you test to **clearly establish** that isolation (or otherwise) has taken place.

(½ mark)

(f) A three-phase TPS cable is to be installed as the mains to a three-phase electrical installation.

State **TWO** reasons why the loads in the installation should be balanced (as much as possible) over the three phases.

(2 marks)

(1)

(2)

(turn over)

Question 1 continued

(g) (i) State the recommended maximum residual current rating of an RCD used for socket-outlet final subcircuits in a kindergarten?

(1 mark)

(ii) An RCD protects a circuit and a fixed-wired Class I electrical appliance.

The residual current device (RCD) has operated. What has the RCD detected that would cause it to operate?

(1 mark)

(h) State **TWO** different methods that are used to provide the starting torque for a single-phase induction motor.

(2 marks)

(1)

(2)

(i) (i) State the easiest method of reversing the direction of rotation of a three-phase induction motor controlled by a **DOL starter**.

(1 mark)

(ii) State the easiest method of reversing the direction of rotation of a three-phase induction motor controlled by a **star/delta starter**.

(1 mark)

(turn over)

Question 1 continued

(j) There are three methods by which a lamp can produce light.

State **TWO** of those methods.

(2 marks)

(1) ____

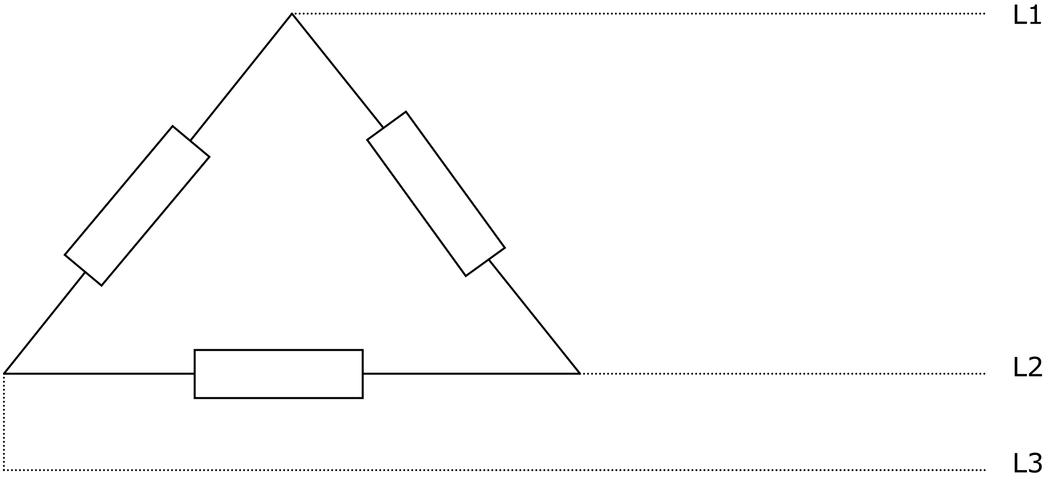
(2) ____

(turn over)

Question 2

(a) **Introduction**

The following diagram represents three loads each with a resistance of 78.5Ω connected to a 400V, three-phase supply.



Use the information in the introduction of this question to answer parts (a)(i), (ii), (iii) and (iv)

(i) Calculate the **phase** current flowing.

(2 marks)

(ii) Calculate the **line** current flowing.

(2 marks)

(turn over)

Question 2 continued

(iii) Calculate the **power** dissipated.

(2 marks)

(iv) Calculate the power dissipated if the three loads were connected **in star**.

(1 mark)

(b) Most appliances sold in New Zealand are designed to operate at 230V or 240V. An electric heater is rated at 2kW when operated at 230V. Calculate the power output when supplied at 240V

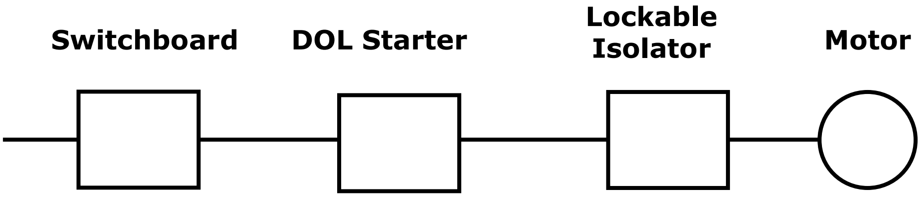
(3 marks)

(turn over)

Question 3

Introduction

The following figure is a block diagram of a three-phase motor circuit. There are no other connections to the circuit.



The motor circuit is protected by HRC fuses on a three-phase switchboard.

The lockable isolating switch and DOL starter are located adjacent to the motor.

Use the information in the introduction of this question to answer parts (a), (b), (c) and (d)

(a) Describe how to isolate the motor and wiring to ensure it is safe to disconnect.

(3½ marks)

(b) The motor has been isolated and disconnected at the isolator.

Describe the actions to be taken to ensure that the work area is safe to be left unattended?

(1 mark)

(turn over)

Question 3 continued

(c) The motor has been cleaned and the bearings replaced. No electrical work was carried out.

A multi-function test instrument with the required functions is to be used to test the motor to ensure it is safe to connect to the electricity supply.

Two instrument tests need to be carried out on the motor to ensure it is safe to connect to the electricity supply. The first test is a protective earthing conductor test. **For the other test state**:

- The name of the test.
- The function and range selected on the multimeter
- How the test is carried out.
- A test result that will permit the motor to be reconnected.

(3½ marks)

(d) You are required to put the motor back into service.

Describe the actions to be taken to ensure it is safe to reconnect the motor.

(2 marks)

(turn over)

Question 4

Every low voltage electrical installation has a switchboard.

(a) A low voltage, MEN electrical installation incorporates an MEN switchboard and a distribution switchboard.

(i) Which switchboard would be connected **electrically** closest to the point of supply?

(1 mark)

____

(ii) State **THREE** **other** features of MEN switchboard which are not found with a distribution switchboard.

(3 marks)

(1) ______________________________

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(2) ______________________________

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(3) ______________________________

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(b) State **TWO** methods of connecting a low voltage, MEN electrical installation to the mass of earth.

(1 mark)

(1) ______________________________

(2) ______________________________

(turn over)

Question 4 continued

(c) A low voltage, MEN electrical installation incorporates only one MEN switchboard. In the MEN switchboard the MEN link between the main neutral bar and main earth bar is missing.

State **THREE** factors that would occur if there was an earth fault in the installation when the MEN link was missing.

(3 marks)

(1)

(2)

(3)

(d) A low voltage, MEN domestic installation is required to have a main earthing lead.

(i) To which parts of the electrical installation are the ends of the main earthing lead connected?

(1 mark)

(ii) What is required to be attached one end of the main earthing lead?

(1 mark)

(turn over)

Question 5

Introduction

A three-phase, 4-pole, induction motor has the following characteristics:

Frequency	50 Hz
Line voltage	400V
Line current	8.5A
Efficiency	85%
Slip	4%

- The line current lags the voltage by a phase angle of 35^0

Use the information in the introduction to this question answer parts (a), (b) and (c).

(a) Calculate the **rotor speed** of the motor

(5 marks)

Question 5 continued

(b) Calculate the **power factor** of the motor

(1 mark)

(c) Calculate the **output power** of the motor.

(4 marks)

(turn over)

Question 6

(a) Tests have been carried out on a three-phase 400V, Class I, plug-in electrical appliance after it has been repaired. Tests were carried out in the following order:

	Test	**Result**
1st test	Protective earthing conductor test	Out of range
2nd test	Insulation resistance test between phase and earth	Infinity

(i) What type of fault is indicated by the test results?

(1 mark)

____

(ii) State **THREE** actions that need to be taken to ensure the electrical appliance complies with AS/NZS 3760 and is safe to return to service.

(3 marks)

(1) ____

____

(2) ____

____

(3) ____

____

(b) AS/NZS 3000 requires that a test voltage of 500V d.c. is used for an insulation resistance test of a low voltage electrical installation.

(i) State **ONE** reason why a voltage of 500V is applied.

(1 mark)

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(turn over)

Question 6 continued

(ii) State **ONE** reason why the voltage is a d.c. voltage.

(1 mark)

(c) AS/NZS 3000 states that the minimum insulation resistance test results for a low voltage installation is 1MΩ. However, the figure can be reduced to 10,000Ω if there are MIMS elements in the installation.

State the reason why the lower insulation resistance result is permitted.

(2 marks)

(d) State the main reason why a polarity test is carried out on the **mains** of a single-phase, low voltage electrical installation.

(1 mark)

(e) An earth loop impedance test at the main switchboard of a low voltage electrical installation shows a result of 50Ω

State **ONE** reason why such a high test result would be obtained

(1 mark)

(turn over)

Question 7

The method of installing cables in electrical installations depends on the environment in which the wires and cables are to be installed.

(a) TPS sheathed PVC cables are installed in an electrical installation, both indoors and outdoors.

(i) State **TWO** reasons why some TPS sheathed cables would be installed in PVC conduit.

(2 marks)

(1) ____

____

(2) ____

____

(ii) State **TWO** design requirements to be considered when PVC conduit is used outdoors.

(1 mark)

(1) ____

(2) ____

(iii) Extra-low voltage cables are installed in the same conduit as low voltage PVC cables.

State the reason why the extra-low voltage cables are insulated to 230V.

(1 mark)

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____

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turn over)

Question 7 continued

(b) Within the installation cables are installed in open cable ladders and open cable trays.

(i) Some cables carry large currents.

State the reason why is it necessary to securely fasten cables carrying high currents when installed in horizontal cable trays.

(2 marks)

(ii) Telecommunication cables are installed in a separate compartment to low voltage cables in the same cable tray.

State the reason why the telecommunication cables are installed in a separate compartment.

(1 mark)

(iii) What provision is made where an open cable trays passes through the fire-rated wall of a switch room?

(1 mark)

(c) State the main effect on TPS sheathed cables that are installed through walls containing thermal insulation.

(2 marks)

(turn over)

Question 8

(a) State **TWO** factors that reduce the life of an incandescent lamp

(1 mark)

(1) ______________________________

(2) ______________________________

(b) (i) State the main colour emitted by a **high-pressure sodium** lamp.

(½ mark)

____

(ii) State the main colour emitted by a **high-pressure mercury vapour** lamp.

(½ mark)

____

(c) Fluorescent lighting is installed mainly in commercial or industrial installations.

(i) State the **TWO** main functions of a ballast in a fluorescent light fitting.

(2 marks)

(1) ______________________________

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(2) ______________________________

____

(ii) A power-factor correction capacitor is connected across the supply to a fluorescent fitting to improve the power factor of the lighting final subcircuit.

State why the power factor needs correction?

(1 mark)

____

____

(turn over)

Question 8 continued

(iii) An EMI suppressor (capacitor) is connected across the glow starter of a fluorescent light fitting to prevent EMI.

If the EMI suppressor (capacitor) short-circuits, state what the effect would be on the operation of the fluorescent light fitting.

(1 mark)

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(iv) A machine shop includes rotating machinery and has incandescent and fluorescent lights installed.

State the reason why incandescent lighting was installed together with fluorescent lighting in the machine shop.

(1 mark)

____

____

(d) List the **FOUR** essential requirements for good lighting.

(2 marks)

(1) ____

(2) ____

(3) ____

(4) ____

(e) State **TWO** precautions that must be taken when handling and installing halogen lamps.

(1 mark)

(1) ____

(2) ____

(turn over)

Question 9

(a) A **three-phase RCD** protects a final subcircuit supplying a three-phase, 5 pin socket outlet.

Describe the internal operation of the **three-phase RCD** when there is an active (phase) to earth fault in an electrical appliance that is plugged into the 5 pin socket outlet.

(4 marks)

(b) An RCD trip test has been carried out on a PRCD (portable residual current device). The device passed the trip test.

What additional check must be carried out on the PRCD to ensure it is electrically safe?

(2 marks)

(turn over)

Question 9 continued

(c) An existing 230V MEN domestic electrical installation has **no RCD protection** on the switchboard.

A new socket outlet is to be installed in Zone 2 of a bathroom from an existing final subcircuit that supplies three socket outlets.

State **TWO** methods, either of which will provide RCD protection for to the new 230V socket outlet in the bathroom

(2 marks)

(1) ______________________________

(2) ______________________________

(d) An RCBO protects a single-phase final subcircuit. The RCBO provides protection against earth leakage faults.

State **TWO** other types of faults the RCBO provides protection from.

(1 mark)

(1) ______________________________

(2) ______________________________

(e) The phase and neutral on the supply side of a single phase RCD have been transposed.

Would the RCD operate if it detected an earth leakage fault on the circuit it protects? State a reason to support your answer.

(1 mark)

For Candidate’s Use

In the box, write the number of **EXTRA** sheets you have used. Write **NIL** if you have not used any

For Examiner’s Use Only		
Questions Answered	**Marks**	
1		
2		
3		
4		
5		
6		
7		
8		
9		
TOTAL		